International Journal of Advanced Research in Engineering and Technology (IJARET)
Volume 12, Issue 11, November 2021, pp. 75-84, Article ID: IJARET_12_11_008
Available online at https://iaeme.com/Home/issue/IJARET?Volume=12&Issue=11
ISSN Print: 0976-6480 and ISSN Online: 0976-6499
DOI: https://doi.org/10.34218/IJARET.12.11.2021.008

© **IAEME** Publication **Scopus** Indexed

ANALYSIS OF THAI DENDROCALAMUS GIGANTUES BAMBOO (TDG) STRIPS OF PRODUCTION IN A DIFFERENT METHOD

Krittapat Kitiyanun
Ph.D. Student in Engineering Law and Inspection, Faculty of Engineering,
Ramkhamhaeng University, Humark, Bangkok 10240 Thailand

Dr. Waranon Kongsong
Assistant Professor in the Engineering Law and Inspection, Faculty of Engineering,
Ramkhamhaeng University, Humark, Bangkok 10240 Thailand
Orcid: 0000-0003-2651-8476

Dr. Chaleeporn Thammapornram
Engineering Law and Inspection, Faculty of Engineering,
Ramkhamhaeng University, Humark, Bangkok 10240 Thailand
Orcid: 0000-0003-2273-5473

ABSTRACT

The aim of this research is analysis the production of TDG bamboo strips with 3 different methods found that Method 3 is the method that can produce the most bamboo strips, with approximately 1470 pieces of bamboo strips or about 183 clumps in 30 days. Statistical analysis with Turkey HSD It was found that when comparing the correlation values of Method 1(A) and Method 2(B), the p-value was 0.8824916 so insignificant, Method 1(A) and Method 3(C) the p-value was 0.0075142 significant, and Method 2(B) and Method 3(C) the p-value was 0.00018048 significant. Bonferroni and Holm result from Method 1(A) and Method 2(B), the p-value was 0.6486016 so insignificant, Method 1(A) and Method 3(C) the p-value was 0.0053856 significant, and Method 2(B) and Method 3(C) the p-value was 0.00018846 significant. The Statistical analysis shows that method 3 more significant

Key words: Dendrocalamus Gigantues Bamboo (TDG), Tukey's HSD, Holm–Bonferroni method.

Cite this Article: Krittapat Kitiyanun, Waranon Kongsong and Chaleeporn Thammapornram, Analysis of Thai Dendrocalamus Gigantues Bamboo (TDG) Strips of Production in a Different Method, *International Journal of Advanced Research in Engineering and Technology (IJARET)*. 12(11), 2021, pp. 75-84.
https://iaeme.com/Home/issue/IJARET?Volume=12&Issue=11

1. INTRODUCTION

TDG bamboo is considered bamboo that has been studied and researched in Thailand. Physical properties of TDG bamboo. TDG bamboo from Nan province research by the engineering department, Ramkhamhaeng University, from 2018-2019.[3] The research data divided into two sections as following the test referred to ASTM D143-09 [9] and DPT 1221-51 [10] research for physical properties with the specimens TDG bamboo at the bottom age from 1- 4 years studied for mechanical properties; the results show that at the Internode part resist the load better than the Node part as the following

Tensile Test Results from TDG bamboo age 3 and 4 years, can resist the tensile load of approximately 257.6 - 257.79 MPa.at the Internode area. At the Node, can withstand the tensile pressure around 159.37 - 159.36 MPa the test referred to Standards Test Method for tensile test of wood [11][14][18]

Bending Test, as shown in figure 1 TDG bamboo age 3 and 4 years, can resist the tensile load of approximately 3.47 - 3.48 MPa.at the Internode area. At the Node, can withstand the tensile capacity of about 2.21-2.22 MPa. The test referred to Standards Test for bending test of wood [12][14][18]

Compressive Test, as shown in figure 1 TDG bamboo age 3 and 4 years, can resist the tensile load of approximately 43.79 MPa.at the Internode area. At the Node, can withstand the tensile pressure approximately 29.04 - 29.74 MPa. The test referred to Standards Test for compressive strength of wood [13][14][18]

TDG bamboo is considered bamboo that has been studied and researched in Thailand. The development of TDG bamboo used in the wood processing industry. The production process and production method are considered the most important factors. From the study and research in the past, it was found that problems from making of laminated bamboo in the production process are the production of bamboo strips because TDG bamboo is a thick bamboo and weighs a lot [1][2][3][4][5][6][8][9], the production process by manual labor is considered quite difficult and takes a long time. This research sees the problem and this importance Therefore, the performance of the production of TDG bamboo strips was tested in 3 different ways: using workers and tools, general woodworking, manual labor, and ancient bamboo splitters, and the use of bamboo cutters that were designed for use in the research in particular.

2. RESEARCH OBJECTIVES

In this research, 3 types of bamboo strips production process were analyzed as follows:

1.Production of bamboo strips by labor and use tools in the production of workers

2 Production of bamboo strips by labor by the traditional method

3 Production of bamboo strips with bamboo cutting tools

3. MATERIALS AND METHODS

This research is experimental research that analyzes data from the statistical tests with one-way ANOVA, Tukey HSD, Holm–Bonferroni method. TDG bamboo 3-year-old cut 3 meters long for production of the strips. Analysis of results comparison of the three types of the bamboo strips production process by specifying the control variables are time and number of people, the dependent variable is the number of production. For this research, the time fixed for day or 8 hours work for 1 month.

Figure 1 Production of bamboo strips by manual labor and production tools

The First Method of producing bamboo strips using one person's labor. The production of bamboo strips with this method uses the following tools as shown in figure 1

1. The outlet in the line

2. A small hand saw following the tortoise line. This is the first line to create a trace line.

3 Jigsaws to cut

The Second Method of producing bamboo strips by manual labor Traditional proceedings. By this method, use a bamboo cutting tool called Champa, using strong force to cut as shown in figure 2

Figure 2 Production of bamboo strips by manual labor Traditional proceedings

The 3 Methods of Producing bamboo strips with a specially designed bamboo slitting tool by using labor and bamboo cutting machines as shown in figure 3. The tool has a weight box on the slide rail. The worker moved the box and hit the bamboo with the cutter’s head.

Figure 3 Production of bamboo strips by manual labor Traditional proceedings

4. TESTING AND TESTING STANDARD

This research is experimental research that analyzes data from the statistical tests with one-way ANOVA, Tukey HSD, Holm–Bonferroni method.

4.1. Statistical Test with HSD

Tukey's HSD (honestly significant difference) test, [15] is a single-step multiple comparison procedure and statistical test. It can be used to find means that are significantly different from each other. Named after John Tukey, [16]it compares all possible pairs of means, and is based on a studentized range distribution (q) (this distribution is similar to the distribution of t from the *t-test*.[17] Tukey's test compares the means of every treatment to the means of every other treatment; that is, it applies simultaneously to the set of all pairwise comparisons

$$\mu_i - \mu_j$$

And identifies any difference between two means that is greater than the expected standard error. The confidence coefficient for the set, when all sample sizes are equal, is exactly 1-α for any $0 \leq \alpha \leq 1$. For unequal sample sizes, the confidence coefficient is greater than $1 - \alpha$. In other words, the Tukey method is conservative when there are unequal sample sizes.

The Test Statistic Tukey's test is based on a formula very similar to that of the *t*-test. In fact, Tukey's test is essentially a *t*-test, except that it corrects for family-wise error rate.

The formula for Tukey's test is:

$$q_s = \frac{Y_A - Y_B}{SE}$$

where Y_A is the larger of the two means being compared, Y_B is the smaller of the two means being compared, and SE is the standard error of the sum of the means. This q_s value can then be compared to a q value from the studentized range distribution. If the q_s value is *larger* than the critical value q_α obtained from the distribution, the two means are said to be significantly different at level

$$\alpha : 0 \leq \alpha \leq 1$$

Since the null hypothesis for Tukey's test states that all means being compared are from the same population (i.e. $\mu_1 = \mu_2 = \mu_3 = ... = \mu_k$), the means should be normally distributed (according to the central limit theorem). This gives rise to the normality assumption of Tukey's test.

4.2. Holm – Bonferroni Method

In statistics, the Holm–Bonferroni method, [18] also called the Holm method or Bonferroni–Holm method, is used to counteract the problem of multiple comparisons. It is intended to control the family-wise error rate and offers a simple test uniformly more powerful than the Bonferroni correction. It is named after Sture Holm, who codified the method, and Carlo Emilio Bonferroni. When considering several hypotheses, the problem of multiplicity arises: the more hypotheses are checked, the higher the probability of obtaining Type I errors (false positives). The Holm–Bonferroni method is one of many approaches for controlling the family-wise error rate (probability that one or more Type I errors will occur) by adjusting the rejection criteria for each of the individual hypotheses. The method is as follows:

Suppose we have m p-values, sorted into order lowest-to-highest P1,……, PN and their corresponding hypotheses H1,……, HK. You want the familywise error rate to be no higher than a certain prespecified significance level . Is $P_1 < \alpha/m$ if so, reject H_2 and continue to the next step, otherwise exit. Is $P_2 < (m-1)$ if so,reject H_2 and continue to the next step,otherwise exit and so on :for each P valaue ,test whether

$$P_k < \frac{\alpha}{m + 1 - k}$$

If so, reject H_k and continue to examine the larger P values, otherwise Exit. This method ensure that the family –wise error rate ≤ α

5. EXPERIMENT RESULTS AND DISCUSSION

The results of the production process testing during 30 days found that Method 3 was the best method, capable of producing approximately 1470 pieces of bamboo strips or about 183 clumps, depending on the skill of the laborers in using the tools. Method 2 capable of producing approximately 424 pieces or approximately 53 clumps were produced, and Method 1 was able to produce 576 pieces or approximately 72 clumps. The test results are shown in table 1 , table 2 and figure 4 comparison of each method.

Table 1 The results of each production method

Process	**Total of production per day**																													
method1	8	8	16	16	48	16	8	16	48	8	16	16	8	8	48	16	8	16	16	8	48	8	8	16	48	8	16	16	48	8	8
method2	48	16	8	8	16	8	16	8	16	8	8	16	48	16	8	8	16	8	8	8	8	16	16	16	16	16	16	8	16	16	16
method3	16	192	48	48	16	48	16	8	192	16	48	16	48	16	16	8	192	48	48	16	16	16	8	48	192	48	16	16	16	8	8

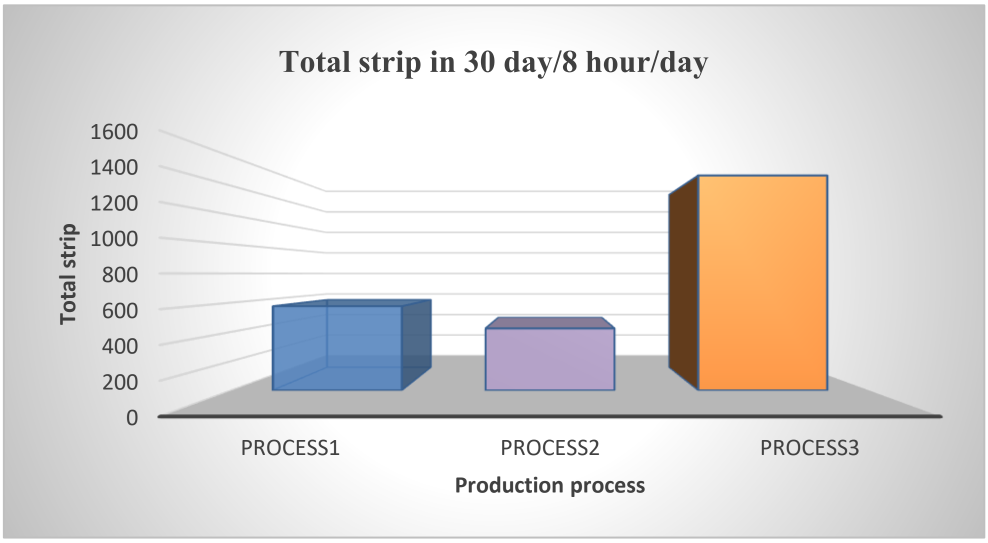

Figure 4 Total stips production in 30 days

The results of the analysis of production processes that can be produced per day, minimum and maximum. The results of the experiment are as follows.

Method 1 Production capacity of bamboo strips, minimum 8 pieces, maximum 48 pieces per day

Method 2 production capacity of bamboo strips, minimum 8 pieces, maximum 48 pieces per day

Method 3 Production capacity of bamboo strips, minimum 8 pieces, maximum 192 pieces per day

The test results are shown in figure 5

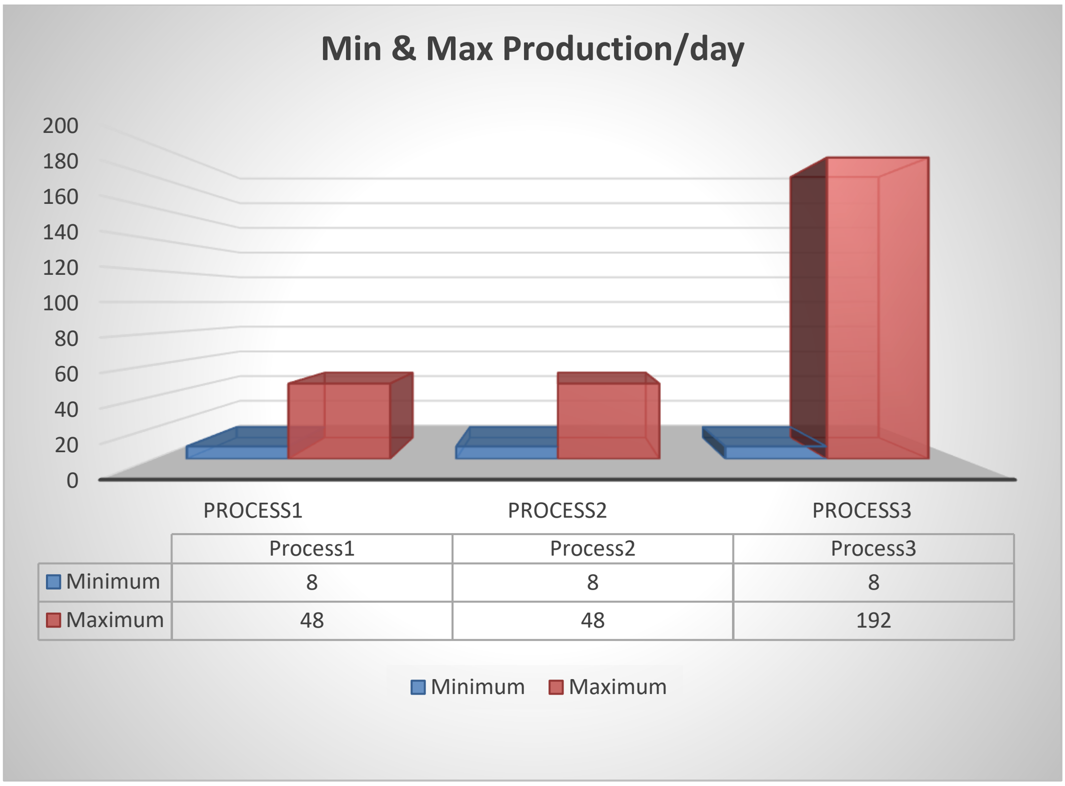

Figure 5 Maximum and Minimum Production

Table 2 The results of the production process test during 30 days

Process of work						
	Method 1		**Method 2**		**Method3**	
Day	Strips	culm	Strips	culm	Strips	culm
1	8	1	48	6	16	2
2	8	1	16	2	192	24
3	16	2	8	1	48	6
4	16	2	8	1	48	6
5	48	6	16	2	16	2
6	16	2	8	1	48	6
7	8	1	16	2	16	2
8	16	2	8	1	8	1
9	48	6	8	1	192	24
10	8	1	16	2	46	6
11	16	2	48	6	48	6
Day	Strips	culm	Strips	culm	Strips	culm
12	16	2	16	2	16	2
13	8	1	8	1	48	6
14	8	1	8	1	16	2
15	48	6	16	2	16	2
16	16	2	8	1	8	1
17	8	1	8	1	192	24
18	16	2	8	1	48	6
19	16	2	8	1	48	6
20	8	1	16	2	16	2
21	48	6	16	2	16	2
22	8	1	16	2	16	2
23	8	1	16	2	8	1
24	16	2	16	2	48	6
25	48	6	16	2	192	24

26	8	1	8	1	48	6
27	16	2	16	2	16	2
28	16	2	8	1	16	2
29	48	6	8	1	16	2
30	8	1	8	1	8	1
Total	576	72	424	53	1470	184
Average	19.2	2.4	14.1	1.8	49	6.1
Variance	227.8	3.6	100.1	1.6	3503.6	54.7

From table 3 and figure the mean production of bamboo strips by Method 1 was approximately 19.2 pieces per day, and Method 2was approximately 14.13 pieces per day, and the last method was approximately 49 pieces per day. Median value all 3 methods were 16 pieces per day.

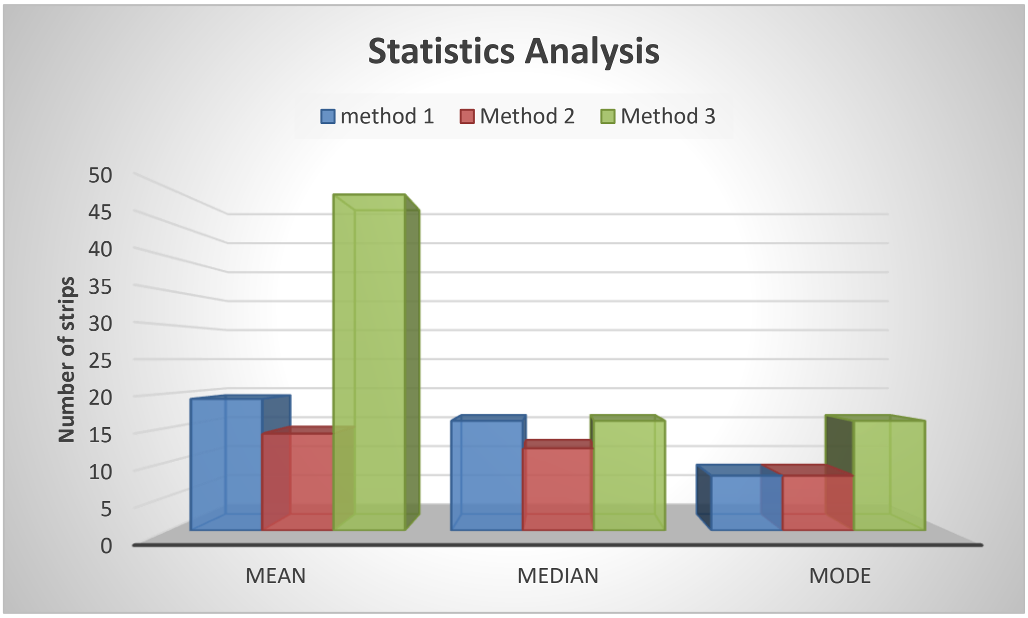

Figure 6 Satistics analysis

Table 3 Analysis the production method

Day	Process1	Process2	Process3
	No.strip	No.strip	No.strip
Mean	19.2	14.1	49
Standard Error	2.755308356	1.82683278	10.80687308
Median	16	12	16
Mode	8	8	16
Standard Deviation	15.0914454	10.00597523	59.19168162
Sample Variance	227.7517241	100.1195402	3503.655172
Kurtosis	0.1938217	7.887040097	2.530890407
Skewness	1.355193403	2.740547829	1.957832388
Range	40	40	184
Minimum	8	8	8
Maximum	48	48	192
Sum	576	424	1470
Count	30	30	30

6. CONCLUSION

For this research analysis with One way Anova with post – hoc Tukey HSD test Calculator with Scheffe, Bonferroni and Holm multiple comparison calculation also provide the results as shown in table 4

Table 4 Analysis the statistic

Descriptive statistics of your k=3 independent treatments:

Treatment →	A	B	C	Pooled Total
observations N	31	31	31	93
sum $\sum x_i$	584.0000	456.0000	1,448.0000	2,488.0000
mean $\bar{x}$	18.8387	14.7097	46.7097	26.7527
sum of squares $\sum x_i^2$	17,728.0000	9,536.0000	171,840.0000	199,104.0000
sample variance s^2	224.2065	94.2796	3,473.4796	1,440.6882
sample std. dev. s	14.9735	9.7098	58.9362	37.9564
std. dev. of mean $SE_{\bar{x}}$	2.6893	1.7439	10.5853	3.9359

The result has shown that processes number 3 or C have high performance compared to the three methods. The Tukey HSD results compared the productivity of each method results as shown in table 5 Statistical analysis with Turkey HSD It was found that when comparing the correlation values of Method 1(A) and Method 2(B), the p-value was 0.8824916 so insignificant, Method 1(A) and Method 3(C) the p-value was 0.0075142 significant, and Method 2(B) and Method 3(C) the p-value was 0.00018048 significant.

Bonferroni and Holm result from Method 1(A) and Method 2(B), the p-value was 0.6486016 so insignificant, Method 1(A) and Method 3(C) the p-value was 0.0053856 significant, and Method 2(B) and Method 3(C) the p-value was 0.00018846 significant. The Statistical analysis shows that method 3 more significant.

Table 5 Analysis with Tukey HSD

Tukey HSD results

treatments pair	Tukey HSD Q statistic	Tukey HSD p-value	Tukey HSD inferfence
A vs B	0.6466	0.8824916	insignificant
A vs C	4.3648	0.0075142	** $p<0.01$
B vs C	5.0114	0.0018048	** $p<0.01$

Table 5 Analysis with Bonferroni

Bonferroni and Holm results: all pairs simultaineously compared

treatments pair	Bonferroni and Holm T-statistic	Bonferroni p-value	Bonferroni inferfence	Holm p-value	Holm inferfence
A vs B	0.4572	1.9458048	insignificant	0.6486016	insignificant
A vs C	3.0864	0.0080784	** p<0.01	0.0053856	** p<0.01
B vs C	3.5436	0.0018846	** p<0.01	0.0018846	** p<0.01

Although the tools used in the production of bamboo strips with method 3 will be able to produce the most from the test results but for large-scale production, it is still inferior in the industrial sector. Production tools need to be developed to be more automated than it is now. This is because this designed tool still uses the force of a human to cut it. As a result, productivity is still dependent on labor. The more powerful people can produce more, but the advantage of the tools produced is that they save tons of capital and can also use local labor to distribute income to the community.

REFERENCES

[1] INBAR. (2002). Internationall Network for Bamboo and Rattan. *Beijing:INBAR press*

[2] Thammapornram C, (2018). The Innovation of Dendrocalamus Giganteus bamboo beam, Phd.dissertation of Engineering Law and Inspection: *Faculty of Engineering Ramkhamhaeng University*

[3] Thamapornram C, Kongsong, & Buranakarn V (2018). Thai Dendrocalamus Giganteus. *Science, Technology, and Architecture*. *ESTCON Thailand*

[4] Chaleeporn Thammapornram, Waranon Kongsong,Vorasun Buranakarn,effecting Factors of mechanical Properties of Thai Denrocalamus Gigantues Bamboo, *International Journal of Civil Engineering and Technology (IJCIET)* 9(13), 2018,pp. 1457-1467

[5] Kongsricharean Songkarn, (2019). The Innovation of Dendrocalamus Giganteus bamboo Column, Phd.dissertation of Engineering Law and Inspection: *Faculty of Engineering Ramkhamhaeng University*

[6] Kongsricharean Sayan, (2019). The innovation of Thai Dendrocalamus giganteus bamboo joints according to building control Act and safety standard, Phd.dissertation of Engineering Law and Inspection: *Faculty of Engineering Ramkhamhaeng University*

[7] Kongsricharoen, S., Kongsong, W., Tuprakay, S., Tuprakay, S., & Thammapornram, C. (2019). Analysis the shear strength of Thai Dendrocalamus Gigantues (TDG) lamented bamboo by the factor of glue and location of the strips. *International Journal of Civil Engineering and Technology (IJCIET)*, 253-262.

[8] ASTM D143-09. (2009). Standard test method for small clear specimens of timber. West Conshohocken, PA, USA: *ASTM international*

[9] DPT 1221-51. (2551). Standards Test of wood. Thailand: The Bureau of Building Inspection and Control Department of Public Works and Town & Country planning

[10] DPT 1225-51. (2551). Standards Test Method for tensile test of wood. Thailand: The Bureau of Building Inspection and Control Department of Public Works and Town & Country planning

[11] DPT 1224-51. (2551). Standards Test for bending test of wood. Thailand: The Bureau of Building Inspection and Control Department of Public Works and Town & Country planning

[12] DPT 1222-51. (2551). Standards Test for compressive strength of wood. Thailand: The Bureau of Building Inspection and Control Department of Public Works and Town & Country planning

[13] Rachata,P. Waranon K.,Chaleeporn T., Analysis of physical properties Thai Dendrocalamus Gigantues (TDG) bamboo case study strips making. *International Journal of Advanced Research in Engineering and Technology (IJARET),* 816-828

[14] Lowry, Richard “One Way ANOVA-Independent Sanple. Vassar. edu. Archived from the original on October 17,2008.Retired December 4.2008 The contribution of the cardioballistic impulse to tremorgenesis in older adults". *Journal of the Neurological Sciences*. 326 (1–2): 68–74. doi:10.1016/j.jns.2013.01.016

[15] Turkey, John (1949) "Comparing Individual Means in the Analysis of Variance". Biometrics. 5 (2): 99–114. *JSTOR* 3001913

[16] Linton, L.R., Harder, L.D. (2007) Biology 315 – Quantitative Biology Lecture Notes. University of Calgary, *Calgary, AB ai*

[17] Krittapat,K. Waranon K.,Chaleeporn T., Analysis of physical properties ThDendrocalamus Gigantues (TDG) bamboo case study the factor of differnt location Node and Internode. *International Journal of management (IJM),* 308-318